183. (New) A method as claimed in Claim 182 where the changes in the response are related to damage in material.

184. (New) A method as claimed in Claim 182 where the response is used to detect the initiation of a crack.

185. (New) A method as claimed in Claim 182 where the response is used to monitor the growth of a crack.

186. (New) A method as claimed in Claim 182 where the response is used to estimate the length of a crack.

REMARKS

Claims 107-121 and 145-162 have been pending in the application. By this Amendment, Claims 107, 108, 112, 120, 150, 151, 155 and 161 have been amended. New Claims 163-186 are added, of which Claim 179 is independent. The new Claim 179 approximately parallels pending dependent Claim 118. No new matter has been added. All claims are now believed to be in condition for allowance.

Rejection under U.S.C. § 102

Claims 107, 112, 120 and 121 have been rejected under 35 U.S.C. § 102(b) as being anticipated by Thompson. This rejection is respectfully traversed.

The present application is directed towards detecting damage in materials around a fastener using sensor arrays. Mounting an array of sensors around a single fastener such that a linear or circular drive is used with multiple sensing elements, with some elements located in an area less likely to form cracks and other elements located in an area more likely to form cracks, allows for determining location of a crack after the crack forms. In addition, in some arrangements of sensor arrays, length of the cracks can be determined as well. The use of

multiple sense elements, sensor arrays, also provides measurement robustness because additional information from extra sense elements can be used, for example, to validate calibration, provide absolute property measurements, or compensate for temperature variations of the test material.

Thompson is directed towards non-destructive testing of certain metal structures by incorporating in the manufacture of the structure a built-in coil that "will be easy of access, to enable the impedance of the coil to be periodically measured at the said location" (Column 1, lines 22-25, illustrated in Fig. 1). Thompson also teaches measuring differential response between coils positioned around two different fasteners, assuming that a crack will form at only one of the fasteners.

Thompson does not teach or suggest placing multiple sensors around a single fastener, as claimed in the amended Claims 107-108, 112, 120, and 150. The use of the array brings about several benefits that are not available with a single sense coil. For example, sensor arrays in combination with the model-based approach described in the Specification provide for the capability to recalibrate and verify sensor performance using measurement at different temperatures or to just check the lift-off at each element. In contrast, the single coil impedance method of Thompson requires that the periodic measurements be performed at the same temperature; otherwise, the effects of the temperature induced fluctuation in the material properties (such as the electrical conductivity) on the single coil response cannot be separated from the responses due to the presence of a crack. Therefore, Claims 107-108, 11, 120 and 150 are not anticipated by Thompson.

Claims 108, 109, 113-119 and 145-162 have been rejected under 35 U.S C. 103(a) as being unpatentable over Thompson in view of what the Examiner refers to as "the obvious design considerations," such as mounting sensors between layers of structures, mounting a sensor in both ends of the fastener and details of the eddy current sensor and calibrating the sensor. This rejection is respectfully traversed. With respect to claims 108, 113-119 and 145-162, as discussed above, mounting a sensor array instead of a single sensor is significantly different and not obvious over mounting a single sense coil because of the numerous additional benefits that

the sensor arrays bring over a single sense coil. Further, measuring responses of the sensor array requires additional sophisticated techniques that would have rendered the use and implementation of the sensor arrays non-obvious to one skilled of the art at the time of the invention. Therefore, claims 108, 113-119 and 145-162 are not obvious in view of Thompson for at least these reasons and the rejection should be withdrawn.

With respect to Claim 109, the Applicants respectfully disagree that mounting sensors at both ends of the fastener is obvious over teaching of the single sense coil. Mounting sensors at both sides of the fastener allows for monitoring for changes in the properties of the fastener itself (as opposed to only monitoring changes in the properties of the material), which may relate to property changes in structure around the fastener. In addition, mounting sensors at both ends of the fastener has been known to be impractical and hard because often there is access to only one side of the fastener. An artisan skilled in the art would not have found it obvious at the time of the invention to mount sensors around both ends of the fastener. Therefore, Claim 109 is not obvious in view of Thompson and the rejection should be withdrawn.

New claims 163-178 depend on the independent Claims 107, 112, and 120 and are not anticipated by Thompson for at least the same reasons as the corresponding independent claims. New independent Claim 179 roughly parallels pending dependent Claim 118 and recites mounting multiple eddy-current sensors and fasteners and therefore is not anticipated or obvious in view of Thompson for at least the same reasons as described above.

CONCLUSION

In view of the above amendments and remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned at (978) 341-0036.

Respectfully submitted,

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Dated: 7/7/3

MARKED UP VERSION OF AMENDMENTS

Claim Amendments Under 37 C.F.R. § 1.121(c)(1)(ii)

107. (Twice Amended) A method for monitoring damage at a fastener comprising:

mounting an eddy current sensor array to a test substrate under the head of a fastener; and

sensing response of the test substrate to a magnetic field imposed by the eddy-current sensor.

108. (Twice Amended) A method of monitoring damage at a fastener comprising:

mounting an eddy-current sensor array to a structure near a fastener, the sensor being mounted between layers of the structure attached by the fastener; and

sensing response of the test substrate to a magnetic field imposed by the eddy-current sensor.

112. (Twice Amended) A method for monitoring damage at a fastener comprising:

mounting at least two eddy-current sensor[s] arrays on a test substrate around respective fasteners;

connecting drive and sense conductors of the eddy-current sensors with a single cable to a data acquisition system; and

sensing response of the test substrate to a magnetic field imposed by the eddy-current sensors.

120. (Twice Amended) A method for monitoring damage at a fastener comprising:

mounting an eddy-current sensor array with [in] a cylindrical support material shaped in the form of a washer;

mounting the cylindrical support to a test substrate under a fastener head; and

sensing response of the test substrate to a magnetic field imposed by the eddy-current sensor.

150. (Amended) A method as claimed in Claim 108 where the eddy current sensor has at least [one drive winding and at least one sense element] two drive conductors and the current changes direction in at least one conductor.

151. (Amended) A method as claimed in Claim 108 [150] further comprising calibrating each sense element by adjusting the response to an appropriate level.

155. (Amended) A method as claimed in Claim 108 [150], where the eddy current sensor has a periodic magnetic field produced by linear segments of the drive winding.

161. (Amended) A method as claimed in Claim 112 where [each sensor has respective drive and sense conductors] the drive conductors of at least two sensors are connected in series.